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FOREST INSECT INVESTIGATIONS

TREE MEDICATION AS A CONTROL OF  
THE MOUNTAIN-PINE BEETLE IN WESTERN  
WHITE PINE

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March 13, 1933

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### Introduction

The injection of chemicals toxic to bark beetles into trees infested with these insects in an attempt to control them, has been experimented with for the past several years by entomologists of the Bureau. Studies have been made by Patterson in California; Earl, St. George, and Caird in North Carolina; and St. George, Gibson and Rust in Montana.

The work in white pine is a comparatively recent innovation. Gibson, assisted by Rust and Foley, instituted the work in June and July of 1930 by medicating 7 trees. Later, in August of the same year, St. George and DeLeon treated six more trees. During the 1931 season, Gibson, assisted by Foley, Scott and Farmer injected 25 trees, and later in the same season Bedard assisted by the same three men treated 18 more trees. In 1932, Bedard and Foley medicated 31 trees. All this work was done on the Weniksu National Forest near Metolite Falls, Washington.

This report summarizes the work that has been done in the medication of western white pine during the past three years.

### Method of Injection

Gibson, during the early part of the work in 1930, experimented entirely to develop a technique of injecting the poison solution into the white pine trees by the saw-kerf method. This method was first used by St. George at Asheville, N. C. In describing this method, St. George<sup>1</sup> writes, "To replace the Lipman and Gordon Method, Dr. Craighead suggested

making a shallow saw cut around the tree. The poison was to be held in the cut by means of a rubber bandage until absorbed by the vessels in the more active outer rings. This would also enable the poison to be in close proximity to the attacking beetles which work in the inner bark next to the wood."

Gibson attempted the application of this method by wrapping a wide rubber tube around the tree so that the tube covered the saw kerf. A canvas band was then strapped tightly over the rubber so that upon inflation, the tube would be confined to the area of and forced against the saw kerf sufficiently hard to prevent leakage of the solution to be injected. The solution was allowed to flow from a can suspended above the saw kerf, through a metal tube into the kerf. Successful injection was secured, but the method was abandoned because it was considered too complicated for general control work and inadequate for all shapes of trees.

Further experimentation was done by using a band made of heavy cardboard. Both the top and bottom edges of this band were tacked to the tree, with the bottom edge tacked just below the saw kerf, so that a trough was formed which would hold several quarts of solution between the band and the tree. Bristol board, press board, and bristol board impregnated with paraffin were used, but none of these gave the desired results, because the solution quickly softened the paper and caused it to break.

Later in the 1930 season, while St. George, Gibson and Aust were medicating lodgepole pine in Montana, Aust perfected a collar to be used to supplant the method then in use. St. George and Gibson<sup>2</sup> describe

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<sup>2</sup> St. George, R. A. & Gibson, A. L. 1931. Tree Injection Studies with Lodgepole Pine and Notes on Western White Pine. Unpublished report.

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the Rust collar as follows. "The collar consisted of a sheet of tin that had a smaller diameter at the base than at the top, causing the latter to flare out when the former edge was fastened by being tacked to the tree. Along one side an S-shaped flange made a tight connection possible. For very large trees it was found possible to attach one sheet of tin to another by means of the flange, making it possible to use them on any tree regardless of its diameter. In order to prevent leakage along the seam and around the lower tacked edge, a thin layer of cup grease, the consistency of 'zerolene' was used."

In the application of this method, the saw kerf is first made. A strip of bark about 3 inches wide is then removed below, and adjoining the kerf, so that a smooth surface is secured for attachment of the collar. The exposed wood is smeared with grease and the bottom edge of the collar fastened to the wood directly below the saw kerf with shingle nails. Gibson and Rust found that it was easier and required less grease to grease the bottom inner edge of the collar rather than the tree.

Unless otherwise stated, the tin collar method is the one used to inject the white pine trees discussed in this report. This method was used to test the toxicity of various chemicals, but experiments are being performed to devise a simpler technique of injection, because it is felt that the tin-collar method requires too much skill when it is applied properly.

#### Late 1930 Studies

St. George and DeLeon medicated six western white pines in the late summer of 1930. Table I has been taken from the report of St. George and Gibson<sup>2</sup> and shows the solutions with which the trees were injected and the results of these injections.

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<sup>2</sup> St. George, R. A. & Gibson, A. L. 1931. Tree Injection Studies with Lodgepole Pine and Notes on Western White Pine. Unpublished report.

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TABLE 1  
INJECTION OF INFESTED WESTERN WHITE PINE

| Tree number: | Solution                                  | Amts.                         | time      | Condition of Kerf                                                                   | :Days :<br>:treat.:<br>:final :<br>:exam. : | Distribution of Indicator:                                                                                 | Effect on brood                                                                                  |
|--------------|-------------------------------------------|-------------------------------|-----------|-------------------------------------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1466         | :Sodium arsenate<br>:Water to             | : ½ lb.:<br>: 2 qts:          | : 4 days: |                                                                                     | : 35                                        | :bg.* in streaks to ground,<br>:below 1'. Not in outer 7<br>:rings.ag.up outer ring in<br>:streaks to top. | :100% killed full in-<br>:festcd length except<br>:few parent adult<br>:beetles,no eggs hatched. |
| 1470         | :Sodium arsenate<br>:Water to             | : 2 lbs.:<br>:12 qts:(about): | :12 days: |                                                                                     | : 35                                        | :ag.** in streaks to 10 ft.                                                                                | :95% killed to 10'<br>:brood emerged above.                                                      |
| 1465         | :Potassium cyanide<br>:Water to           | : ½ lb.:<br>: 2 qts:          | :13 days: | Pitch globules<br>:floating in tin<br>:collar                                       | : 39                                        | :ag.up outer rings to 10'<br>:in streaks to 25' ag.                                                        | :100% kill to 10' ag.:<br>:in streaks to 25'.<br>:Rest of brood living.                          |
| 1467         | :Potassium cyanide<br>:Water to           | : 2 lbs.:<br>: 2 qts:         | : 1 day : |                                                                                     | : 39                                        | :ag. up outer rings to 40'<br>:in streaks to 60'.                                                          | :bg. 50% kill; ag. 100%<br>:kill to 40':in streaks<br>:to 60'.                                   |
| 1468         | :Sodium flouride<br>:Water to             | : 1 lb.:<br>: 3 qts:          | :1½ days: | Poison in bottom of:<br>:collar.(only 3%<br>:soluble according<br>:to Mr. Bateman). | : 37                                        | :ag. up outer rings to 40'<br>:in streaks to 90' ag.                                                       | :Poor brood from 50 to<br>:140' ag.                                                              |
| 1469         | :Sodium flouride<br>:Water to             | : ½ lb.:<br>: 2 qts:          | : 2 days: | Clean                                                                               | : 37                                        | :up outer rings to 30' ag.:<br>:in streaks to 60' ag.                                                      | :95% kill to 40' ag.:<br>:70% kill to 41-60'ag.:<br>:very little effect.                         |
| 1471         | :Light green<br>Normal:Water to<br>tree : | : ½ gram:<br>: 2 qts:         | : 2 days: |                                                                                     | : 35                                        | :up outer 2 rings in streaks:<br>:to 80' ag.                                                               |                                                                                                  |

\*\*ag. - above girdle

\*bg. - below girdle

It can be seen in Table I that best results were obtained in tree No. 1466 which was treated with an aqueous solution of sodium arsenate.

### 1931 Studies

During this season, 43 infested white pine trees were injected. These have been arranged in Table II, showing the solution with which each tree was injected, time elapsing between date of attack and date of injection, condition of cambium at time of injection, time elapsing between date of injection and date of examination, and the effect on the brood.

TABLE II  
INJECTION OF INFESTED WHITE PINES 1931

| Tree number: | Date of attack: | Date of injection: | Elapsed time from attack to injection: | Solution      | Amount:    | Phloem exam.: | Date of injection: | Elapsed time from injection to exam.: | Effect on brood                                                                     |
|--------------|-----------------|--------------------|----------------------------------------|---------------|------------|---------------|--------------------|---------------------------------------|-------------------------------------------------------------------------------------|
|              |                 |                    | Days                                   |               |            |               |                    | Days                                  |                                                                                     |
| 31-2         | 7/6             | 7/15               | 7                                      | Den. alcohol  | 3 qts.     | Living        | 9/16               | 63                                    | No mortality below saw kerf. 50% killed from saw kerf to 1'. No mortality above 1'. |
| 31-6         | 7/11            | 7/16               | 5                                      | " "           | " "        | "             | 7/1/32             | 350                                   | 25% control in streaks to top.                                                      |
| 31-1         | 7/10            | 7/15               | 5                                      | Wood alcohol  | " "        | "             | 9/16               | 63                                    | 99% killed from ground to 10'. 75% killed from 10' to 25'. Normal brood above 25'.  |
| 31-22        | 6/28            | 7/18               | 20                                     | " "           | " "        | Dead          | 7/3/32             | 349                                   | No mortality.                                                                       |
| 31-26        | 7/20            | 7/28               | 8                                      | " "           | " "        | Living        | 7/3/32             | 339                                   | No mortality.                                                                       |
| 31-27        | 7/20            | 7/28               | 8                                      | " "           | " "        | "             | 7/3/32             | 339                                   | No mortality.                                                                       |
| 31-28        | 7/22            | 7/28               | 6                                      | " "           | " "        | "             | 7/3/32             | 339                                   | No mortality.                                                                       |
| 31-9         | 7/12            | 7/16               | 4                                      | Sod. arsenate | 1 lb.      | "             | 7/1/32             | 350                                   | 100% killed total infested length which was 65'. Indicator to top 94'.              |
|              |                 |                    |                                        | Water         | 3 1/2 qts. |               |                    |                                       |                                                                                     |
|              |                 |                    |                                        | Den. alcohol  | 1 1/2 qts. |               |                    |                                       |                                                                                     |
| 31-10        | 7/11            | 7/16               | 5                                      | Sod. arsenate | 1 lb.      | "             | 7/1/32             | 350                                   | 100% killed total infested length which was 87'. Indicator to top 145'.             |
|              |                 |                    |                                        | Water         | 4 1/2 pts. |               |                    |                                       |                                                                                     |
|              |                 |                    |                                        | Den. alcohol  | 1 1/2 pts. |               |                    |                                       |                                                                                     |

(continued)

TABLE II (continued)

| Tree number: | Date of attack: | Date of injection: | Elapsed time from attack to injection: | Solution       | Amounts: | Phloem: exam.: | Elapsed time from injection to exam.: | Effect on brood |                                                                                                                                   |
|--------------|-----------------|--------------------|----------------------------------------|----------------|----------|----------------|---------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------|
| :            | :               | :                  | Days                                   | :              | :        | :              | Days                                  | :               |                                                                                                                                   |
| 31-11        | 7/14            | 7/17               | 3                                      | Sod. arsenate: | 1 lb.    | Living         | 7/1/32                                | 349             | :100% killed except for 4" strip from 10' to 35' above saw kerf.                                                                  |
| :            | :               | :                  | :                                      | :Water         | :2 qts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Den. alcohol: | :1 qts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-16        | 7/14            | 7/17               | 3                                      | Sod. arsenate: | 1 lb.    | "              | 7/1/32                                | 349             | :100% killed total infested length which was 70'. Indicator to top 135'.                                                          |
| :            | :               | :                  | :                                      | :Water         | :4 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Den. alcohol: | :1 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-5         | 7/10            | 7/16               | 6                                      | Sod. arsenate: | 1 lb.    | "              | 7/1/32                                | 350             | :100% killed total infested length which was 105'. Indicator to top 150'.                                                         |
| :            | :               | :                  | :                                      | :Water         | :4 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Wood alcohol: | :1 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-41        | 7/26            | 8/1                | 6                                      | Sod. arsenate: | 1 lb.    | "              | 7/5/32                                | 340             | :100% killed total infested length which was 100'. Indicator to top 116'.                                                         |
| :            | :               | :                  | :                                      | :Water         | :4 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Wood alcohol: | :1 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-42        | 7/26            | 8/1                | 6                                      | Sod. arsenate: | 1 lb.    | "              | 7/5/32                                | 340             | :100% killed total infested length which was 112'. Indicator to top 148'.                                                         |
| :            | :               | :                  | :                                      | :Water         | :4 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Wood alcohol: | :1 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-43        | 7/26            | 8/1                | 6                                      | Sod. arsenate: | 1 lb.    | "              | 7/5/32                                | 340             | :100% killed total infested length which was 100' except for 6" strip from kerf up 20' caused by cat face. Indicator to top 142'. |
| :            | :               | :                  | :                                      | :Water         | :4 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Wood alcohol: | :1 pts.  | :              | :                                     | :               | :                                                                                                                                 |
| 31-19        | 7/14            | 7/18               | 4                                      | Sod. arsenate: | 1 lb.    | "              | 7/2/32                                | 348             | :100% killed total infested length which was 104'. Indicator to top 160'.                                                         |
| :            | :               | :                  | :                                      | :Water         | :2 qts.  | :              | :                                     | :               | :                                                                                                                                 |
| :            | :               | :                  | :                                      | :Wood alcohol: | :1 qts.  | :              | :                                     | :               | :                                                                                                                                 |

(Continued)

TABLE II (continued)

| Tree number: | Date of attack: | Date of injection: | Elapsed time from attack to injection: | Solution                           | Amounts: | Phloem:exen.: | Elapsed time from injection to exam.: | Effect on brood                                                           |
|--------------|-----------------|--------------------|----------------------------------------|------------------------------------|----------|---------------|---------------------------------------|---------------------------------------------------------------------------|
| :            | :               | :                  | Days                                   | :                                  | :        | :             | Days                                  | :                                                                         |
| 31-7         | 7/9             | 7/16               | 7                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | Living   | 7/1/32:       | 350                                   | :100% killed total infested length which was 103'. Indicator to top 140'. |
| :            | :               | :                  | :                                      | Water : 1 $\frac{1}{2}$ qts.       | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 $\frac{1}{2}$ qts. | :        | :             | :                                     | :                                                                         |
| 31-25        | 7/11            | 7/18               | 7                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/2/32:       | 349                                   | :100% killed total infested length which was 64'. Indicator to top 110'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-33        | 7/15            | 7/31               | 16                                     | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/2/32:       | 336                                   | :100% killed total infested length.                                       |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-34        | 7/26            | 7/31               | 5                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/3/32:       | 337                                   | :100% killed total infested length which was 72'. Indicator to top 122'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-35        | 7/26            | 7/31               | 5                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/3/32:       | 337                                   | :100% killed total infested length which was 52'. Indicator to top 115'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-36        | 7/26            | 7/31               | 5                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/3/32:       | 337                                   | :100% killed total infested length which was 88'. Indicator to top 145'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-17        | 7/11            | 7/18               | 7                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/2/32:       | 349                                   | :100% killed total infested length which was 84'. Indicator to top 145'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |
| 31-18        | 7/14            | 7/18               | 4                                      | Sod.arsenate: $\frac{1}{2}$ lb.    | "        | 7/2/32:       | 349                                   | :100% killed total infested length which was 90'. Indicator to top 135'.  |
| :            | :               | :                  | :                                      | Water : 2 qts.                     | :        | :             | :                                     | :                                                                         |
| :            | :               | :                  | :                                      | Wood alcohol: 1 qt.                | :        | :             | :                                     | :                                                                         |

(Continued)

TABLE II (continued)

| Tree number: | Date of attack: | Time from injection to exam.: | Solution | Amounts:                        | Phloem:      | Exam.: | Effect on brood |                                                                          |
|--------------|-----------------|-------------------------------|----------|---------------------------------|--------------|--------|-----------------|--------------------------------------------------------------------------|
|              |                 | Days                          |          |                                 |              | Days   |                 |                                                                          |
| 31-20        | 7/11            | 7/18                          | 7        | Sod.arsenate: $\frac{1}{2}$ lb. | Living       | 7/2/32 | 349             | 100% killed total infested length which was 87'. Indicator to top 150'.  |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-23        | 7/15            | 7/18                          | 3        | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/2/32 | 349             | 100% killed total infested length which was 97'. Indicator to top 148'.  |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-24        | 7/14            | 7/18                          | 4        | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/2/32 | 349             | 100% killed total infested length which was 100'. Indicator to top 155'. |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-29        | 7/21            | 7/28                          | 7        | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/5/32 | 343             | 100% killed total infested length which was 93'. Indicator to top 140'.  |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-30        | 7/26            | 7/28                          | 2        | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/5/32 | 343             | 100% killed total infested length which was 99'. Indicator to top 135'.  |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-31        | 7/20            | 7/28                          | 8        | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/5/32 | 343             | 100% killed total infested length.                                       |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-32        | 7/21            | 7/31                          | 10       | Sod.arsenate: $\frac{1}{2}$ lb. | "            | 7/5/32 | 340             | 100% killed total infested length.                                       |
|              |                 |                               |          | Water : 2 qts.                  |              |        |                 |                                                                          |
|              |                 |                               |          | Wood alcohol: 1 qt.             |              |        |                 |                                                                          |
| 31-3         | 6/26            | 7/15                          | 19       | Sod.arsenate: $\frac{1}{2}$ lb. | Dead, partly | 9/16   | 63              | 100% killed total infested length which was 60'. Indicator to top 90'.   |
|              |                 |                               |          | Water : 3 qts.                  | blue-        |        |                 |                                                                          |
|              |                 |                               |          |                                 | stained:     |        |                 |                                                                          |

(continued)

TABLE II (continued)

| Tree number: | Date of attack: | Date of injection: | Elapsed time from attack to injection: | Solution      | Amount:           | Phloem exam. to exam.:      | Elapsed time from injection: | Effect on brood                                                                                               |
|--------------|-----------------|--------------------|----------------------------------------|---------------|-------------------|-----------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------|
|              |                 |                    | Days                                   |               |                   | Dead, 40% of                | Days                         |                                                                                                               |
| 31-4         | 6/20            | 7/15               | 25                                     | Sod.arsenate: | $\frac{1}{2}$ lb. | circumference blue-stained: | 63                           | 100% killed 2' below kerf, streaks from 2' to base of tree. 100% killed 2' above kerf. Normal brood above 2'. |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
| 31-8         | 7/8             | 7/16               | 8                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | Living                      | 7/1/32                       | 350                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | Few living larvae near base of tree. 100% killed total infested length which was 70'. Indicator to top 145'.  |
| 31-15        | 7/13            | 7/17               | 4                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/2/32                       | 350                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 89'. Indicator to top 145'.                                       |
| 31-21        | 7/13            | 7/18               | 5                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/2/32                       | 349                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 84'. Indicator to top 135'.                                       |
| 31-37        | 7/25            | 7/31               | 6                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/6/32                       | 341                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 110'. Indicator to top 160'.                                      |
| 31-38        | 7/25            | 7/31               | 6                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/6/32                       | 341                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 36'. Indicator to top 63'.                                        |
| 31-39        | 7/25            | 7/31               | 6                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/6/32                       | 341                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 30'. Indicator to top 145'.                                       |
| 31-40        | 7/25            | 7/31               | 6                                      | Sod.arsenate: | $\frac{1}{2}$ lb. | "                           | 7/6/32                       | 341                                                                                                           |
|              |                 |                    |                                        | Water         | 3 qts.            |                             |                              |                                                                                                               |
|              |                 |                    |                                        |               |                   |                             |                              | 100% killed total infested length which was 108'. Indicator to top 145'.                                      |

Table II shows that successful control was secured from all solutions containing sodium arsenate, except tree 31-4 which was examined the same year as treated. This compound was used in two forms for making the injections, "dibasic dried and powdered", and that called "technical crystals". The former would not mix well with wood alcohol, causing the solution to become "milky" and generating some heat.

Examination of the trees injected in 1931 also showed that the saw kerf must be made no more than 3 feet above the base of the tree. Otherwise, the brood in the base of the tree will not be destroyed.

#### 1932 Studies

It was learned from the 1931 studies that poisonous solutions could be injected into infested trees and distributed evenly throughout them to a height of 160 feet. Also, a simple solution of one-half pound of sodium arsenate to three quarts of water resulted in 100 per cent brood mortality. The 1932 studies, therefore, were directed to ascertain how long after attack a tree could be treated successfully by the injection method, the least amount of poison and solution necessary to secure 100 per cent brood mortality, and to evolve a simpler method of injection.

The data concerning the trees injected during the 1932 season have been arranged in Table III showing the solution with which each was injected, time elapsing between date of attack and date of injection, condition of foliage and cambium at time of injection, method of injection, time required to prepare the tree for injection, and the tree diameter. These trees will not be examined until the spring of 1933.

TABLE III  
INJECTION OF INFESTED WHITE PINES 1932

| Tree number | Diameter in inches | Date of attack | Date of injection | Elapsed time from attack to injection | Phloem | Foliage | Solution      | Amount      | Method of injection                                                  | Time required to prepare tree |
|-------------|--------------------|----------------|-------------------|---------------------------------------|--------|---------|---------------|-------------|----------------------------------------------------------------------|-------------------------------|
|             |                    |                |                   | Days                                  |        |         |               |             |                                                                      | Min.                          |
| 31-32       | 20.0               | 7/27           | 9/5               | 40                                    | Dead   | Green   | Water         | 24 1/2 qts. | Saw kerf and tin collar                                              | 45                            |
| 5-32        | 25.5               | 7/23           | 8/1               | 9                                     | Living | "       | "             | 6 qts.      | " " " " "                                                            | 89                            |
| 21-32       | 13.5               | 7/29           | 9/3               | 36                                    | Dead   | "       | "             | 4 qts.      | " " " " "                                                            | 37                            |
|             |                    | Sept.          |                   |                                       |        |         |               |             |                                                                      |                               |
| 2-32        | 23.5               | 1931 7/26      |                   | 315                                   | "      | Fading  | Wood alcohol  | 3 qts.      | " " " " "                                                            | 123                           |
| 12-32       | 22.0               | 8/1            | 8/9               | 8                                     | Living | Green   | " "           | 3 qts.      | " " " " "                                                            | 75                            |
| 20-32       | 25.5               | 7/29           | 8/17              | 19                                    | "      | "       | " "           | 3 qts.      | " " " " "                                                            | 80                            |
| 29-32       | 19.0               | 7/29           | 8/18              | 20                                    | "      | "       | " "           | 3 qts.      | " " " " "                                                            | 53                            |
| 30-32       | 15.0               | 7/29           | 9/3               | 36                                    | Dead   | "       | " "           | 3 qts.      | " " " " "                                                            | 49                            |
| 3-32        | 16.0               | 6/18           | 7/26              | 38                                    | "      | Red     | Sod. arsenate | 1 lb.       | " " " " "                                                            | 64                            |
|             |                    |                |                   |                                       |        |         | Water         | 2 qts.      |                                                                      |                               |
|             |                    |                |                   |                                       |        |         | Wood alcohol  | 1 qt.       |                                                                      |                               |
| 7-32        | 9.5                | 7/23           | 8/1               | 9                                     | Living | Green   | Sod. arsenate | 1 lb.       | " " " " "                                                            | 39                            |
|             |                    |                |                   |                                       |        |         | Water         | 2 qts.      |                                                                      |                               |
|             |                    |                |                   |                                       |        |         | Wood alcohol  | 1 qt.       |                                                                      |                               |
| 10-32       | 10.0               | 8/1            | 8/9               | 8                                     | "      | "       | Sod. arsenate | 1 lb.       | Tangential holes and tin can. (Modification of Lipman-Gordon method) | 35                            |
|             |                    |                |                   |                                       |        |         | Water         | 2 qts.      |                                                                      |                               |
|             |                    |                |                   |                                       |        |         | Wood alcohol  | 1 qt.       |                                                                      |                               |

(Continued)

TABLE III (continued)

| Tree number | Diameter in: | Date of attack | Date of injection | Elapsed time from attack to injection | Phloem | Foliage | Solution     | Amounts | Method of injection           | Time required to prepare tree |
|-------------|--------------|----------------|-------------------|---------------------------------------|--------|---------|--------------|---------|-------------------------------|-------------------------------|
|             |              |                |                   | Days                                  |        |         |              |         |                               | Min.                          |
| 11-32       | 9.0          | 6/17           | 8/9               | 53                                    | Dead   | Fading  | Sod.arsenate | 1 lb.   | Saw kerf and tin collar       | 50                            |
|             |              |                |                   |                                       |        |         | Water        | 2 qts.  |                               |                               |
|             |              |                |                   |                                       |        |         | Wood alcohol | 1 qt.   |                               |                               |
| 4-32        | 23.0         | 7/24           | 7/26              | 2                                     | Living | Green   | Sod.arsenate | 1 lb.   | " " " " "                     | 81                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |
| 16-32       | 18.0         | 6/14           | 8/10              | 57                                    | Dead   | "       | Sod.arsenate | 1 lb.   | " " " " "                     | 80                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |
| 17-32       | 14.0         | 6/13           | 8/10              | 58                                    | "      | "       | Sod.arsenate | 1 lb.   | " " " " "                     | 32                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |
| 18-32       | 10.0         | 6/18           | 8/10              | 53                                    | "      | Fading  | Sod.arsenate | 1 lb.   | " " " " "                     | 25                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |
| 19-32       | 7.0          | 8/1            | 8/12              | 11                                    | Living | Green   | Sod.arsenate | 1 lb.   | " " " " "                     | 23                            |
|             |              |                |                   |                                       |        |         | Water        | 2 qts.  |                               |                               |
| 6-32        | 20.0         | 7/23           | 8/1               | 9                                     | "      | "       | Sod.arsenate | 1 lb.   | Tangential holes and tin can. | 79                            |
|             |              |                |                   |                                       |        |         | Water        | 4 qts.  |                               |                               |
| 1-32        | 20.5         | 6/15           | 7/26              | 41                                    | Dead   | Red     | Sod.arsenate | 1 lb.   | Saw kerf and tin collar       | 60                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |
| 8-32        | 23.0         | 6/16           | 8/1               | 46                                    | "      | Green   | Sod.arsenate | 1 lb.   | " " " " "                     | 60                            |
|             |              |                |                   |                                       |        |         | Water        | 3 qts.  |                               |                               |

(Continued)

TABLE III (continued)

| Tree number | Diameter in inches | Date of attack | Date of infection | Elapsed time from attack to injection | Place of injection | Condition of foliage | Solution               | Amounts           | Method of injection           | Time required to prepare tree |
|-------------|--------------------|----------------|-------------------|---------------------------------------|--------------------|----------------------|------------------------|-------------------|-------------------------------|-------------------------------|
|             |                    |                |                   | Days                                  |                    |                      |                        |                   |                               | Min.                          |
| 9-32        | 14.0               | 6/16           | 8/3               | 48                                    | Dead               | Green                | Sod. arsenate<br>Water | 1 lb.<br>3 qts.   | Saw kerf and tin collar       | 55                            |
| 14-32       | 16.0               | 8/1            | 8/10              | 9                                     | Living             | "                    | Sod. arsenate<br>Water | 1 lb.<br>3 qts.   | Tangential holes and tin can. | 55                            |
| 22-32       | 24.5               | 7/29           | 9/3               | 36                                    | Dead               | Shading              | Sod. arsenate<br>Water | 1 lb.<br>3 qts.   | Saw kerf and wicking          | 34                            |
| 23-32       | 19.0               | 7/29           | 9/3               | 36                                    | "                  | Green                | Sod. arsenate<br>Water | 1 lb.<br>3 qts.   | " " " "                       | 21                            |
| 15-32       | 11.0               | 8/1            | 8/10              | 9                                     | Living             | "                    | Sod. arsenate<br>Water | 1 lb.<br>2 qts.   | Saw kerf and tin collar       | 45                            |
| 13-32       | 21.0               | 8/1            | 8/10              | 9                                     | "                  | "                    | Sod. arsenate<br>Water | 1 lb.<br>1 qt.    | " " " " "                     | 60                            |
| 24-32       | 18.0               | 7/29           | 9/3               | 36                                    | "                  | "                    | Sod. arsenate<br>Water | 1/8 lb.<br>3 qts. | " " " " "                     | 59                            |
| 26-32       | 26.5               | 7/29           | 8/18              | 20                                    | "                  | "                    | Sod. arsenate<br>Water | 1/8 lb.<br>3 qts. | " " " " "                     | 85                            |
| 27-32       | 26.0               | 7/29           | 8/18              | 20                                    | "                  | "                    | Sod. arsenate<br>Water | 1/8 lb.<br>2 qts. | " " " " "                     | 80                            |
| 25-32       | 11.0               | 7/29           | 9/3               | 36                                    | "                  | "                    | Sod. arsenate<br>Water | 1/8 lb.<br>1 qt.  | " " " " "                     | 39                            |
| 28-32       | 26.0               | 7/29           | 8/18              | 20                                    | "                  | "                    | Sod. arsenate<br>Water | 1/8 lb.<br>1 qt.  | " " " " "                     | 90                            |

It will be noted in Table III that the time required to prepare the tree for injection varies greatly for the individual trees, and even for trees of the same diameter. The time depends directly on the diameter of the tree and the number of difficulties such as cat-faces, convolutions of the trunk, etc., to be overcome. The trees treated by the tin-collar method averaged 18.1 inches in diameter and required an average of 60 minutes per tree. The trees injected by the tangential hole method averaged 15.3 inches and required an average of 56 minutes per tree. Those treated by the wicking method, averaged 21.7 inches and required an average of 27.5 minutes per tree. From these comparisons, it can be seen that in using the first two methods, the time required to inject a tree is about equal. However, if the wicking method proves successful, the time necessary to medicate a tree will be less than half the time required by the other two methods.

#### Effect of Medication on Parent Beetles

In the examination of the trees medicated during 1931, Foley noted that an abnormally large number of parent adult emergence holes were present in the bark of the medicated trees. This observation suggested that although the injection of poisonous solutions destroyed the brood, the parent beetles escaped and attacked other trees.

To secure more information regarding this matter, the bases of two medicated trees were enclosed in cages immediately after medication, and a freshly cut white pine log was placed in each cage. Table IV shows the results of these experiments.

TABLE IV  
EFFECT OF MEDICATION ON PARENT BEETLES

| Cage | Material       | medicated | Sq. ft. of bark | Date examined | Attacks | holes | Number of    |           |           |           |
|------|----------------|-----------|-----------------|---------------|---------|-------|--------------|-----------|-----------|-----------|
|      |                |           |                 |               |         |       | Parent adult | Living    | Dead      | Dead      |
|      |                |           |                 |               |         |       | emergence    | adults in | adults in | adults in |
|      |                |           |                 |               |         |       |              | material  | material  | in cage   |
|      |                |           |                 |               |         |       |              |           |           | larvae    |
| 1    | Medicated tree | 7/27/32   | 81              | 9/13/32       | 517     | 174   | 43           | 482       | 118       | 294       |
|      | Green log      | --        | 9               | 10/11/32      | 42      | 0     | 35           | 22        | --        | 694       |
| 2    | Medicated tree | 8/1/32    | 25              | 9/7/32        | 195     | 28    | 18           | 198       | 14        | 371       |
|      | Green log      | --        | 4.5             | 10/11/32      | 6       | 0     | 4            | 3         | --        | 44        |

It can be seen from these studies that although many parent beetles are killed by medication, some escape and probably attack other trees. However, more study must be made on this subject during the 1933 season. It is possible that the date of medication is an important factor governing whether or not the parent beetles are destroyed.

### Summary

1. During the 1930, 1931 and 1932 seasons, infested western white pine trees were injected with various poisonous solutions.
2. Of these solutions, those containing sodium arsenate were most successful and resulted in 100 per cent brood mortality.
3. The most simple was an aqueous solution comprising one-fourth pound of sodium arsenate (technical crystals) and three quarts of water, which, upon injection, was distributed throughout the tree to a height of 160 feet.
4. However, the present method of injection requires too much skill to be used in general control work and experiments are being performed to devise a simpler means of injection.
5. Although many parent adult beetles are destroyed by medication, a few escape and attack other trees. Studies are being made regarding this matter.